

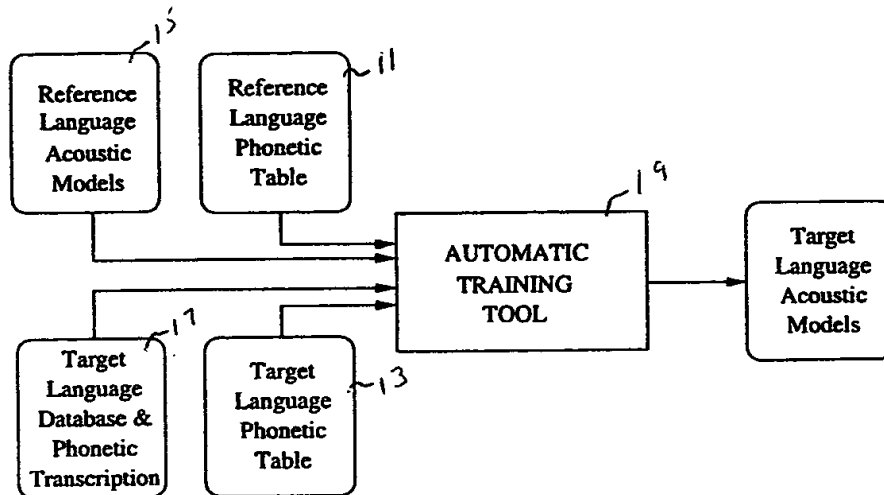
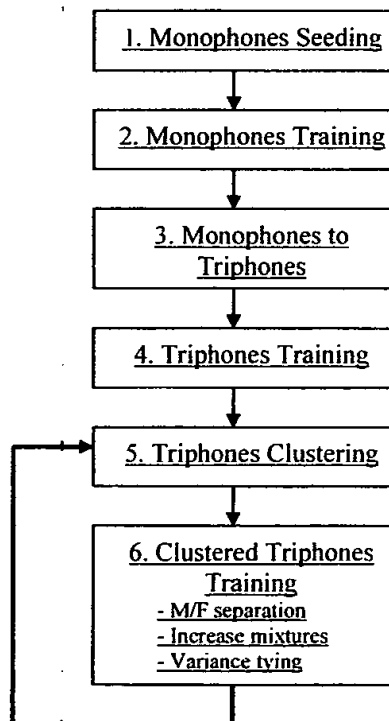


Figure 1: Block diagram of the proposed method performing automatic training in any language.

Figure 2: General block diagram of training scheme



VOWELS AND DIPHTHONGS										
iy	7	vowel	high	front	I	voiced	cont.	unround	round	lax
ih	6	vowel	high	front	I	voiced	cont.	unround	short	tense
uw	7	vowel	high	back	U	voiced	cont.	round	round	lax
uh	6	vowel	high	back	U	voiced	cont.	round	short	tense
ey	8	vowel	mid	front	E	voiced	cont.	unround	round	lax
eh	7	vowel	mid	front	E	voiced	cont.	unround	short	tense
ow	8	vowel	mid	back	O	voiced	cont.	round	round	lax
ao	8	vowel	mid	back	O	voiced	cont.	round	round	lax
ah	6	vowel	mid	central	A	voiced	cont.	unround	short	tense
ae	9	vowel	low	front	A	voiced	cont.	unround	short	lax
aa	8	vowel	low	central	A	voiced	cont.	unround	short	lax
ax	5	vowel	low	central	A	voiced	cont.	unround	short	lax
er	7	vowel	mid	central	E	voiced	cont.	unround	round	tense
ay	8	dipht.			A	voiced	ncont.			
aw	10	dipht.			A	voiced	ncont.			
CONSONANTS AND SEMIVOWELS										
p	5	cons.	stop	front	bilabial	unv.	ncont.	fortis	ncoron.	ant. unst.
b	5	cons.	stop	front	labial	voiced	ncont.	lenis	ncoron.	ant. unst.
t	5	cons.	stop	central	alveolar	unv.	ncont.	fortis	coron.	nant. unst.
d	5	cons.	stop	central	alveolar	voiced	ncont.	lenis	coron.	nant. unst.
k	5	cons.	stop	back	velar	unv.	ncont.	fortis	ncoron.	nant. unst.
g	5	cons.	stop	back	velar	voiced	ncont.	lenis	ncoron.	nant. unst.
ch	7	cons.	affric.	central	alveopalatal	unv.	ncont.	fortis	coron.	nant. strid.
jh	5	cons.	affric.	central	alveopalatal	voiced	ncont.	lenis	coron.	nant. strid.
f	7	cons.	fricat.	front	labiodental	unv.	cont.	fortis	ncoron.	ant. nstrid.
v	5	cons.	fricat.	front	labiodental	voiced	cont.	lenis	ncoron.	ant. nstrid.
th	7	cons.	fricat.	front	interdental	unv.	cont.	fortis	ncoron.	ant. nstrid.
dh	5	cons.	fricat.	front	interdental	voiced	cont.	lenis	ncoron.	ant. nstrid.
s	8	cons.	fricat.	central	alveolar	unv.	cont.	fortis	coron.	nant. strid.
z	6	cons.	fricat.	central	alveolar	voiced	cont.	lenis	coron.	nant. strid.
sh	8	cons.	fricat.	central	alveopalatal	unv.	cont.	fortis	coron.	nant. strid.
zh	7	cons.	fricat.	central	alveopalatal	voiced	cont.	lenis	coron.	nant. strid.
hh	5	cons.	fricat.	back	velar	unv.	ncont.	fortis	ncoron.	nant. unst.
m	5	cons.	nasal	front	bilabial	voiced	cont.	ufl.	ncoron.	ant. unst.
n	5	cons.	nasal	central	alveolar	voiced	cont.	ufl.	coron.	nant. unst.
en	6	cons.	nasal	central	alveolar	voiced	ncont.	ufl.	ncoron.	nant. unst.
ng	6	cons.	nasal	back	velar	voiced	cont.	ufl.	ncoron.	nant. unst.
l	6	semiv.	liquid	central	alveolar	voiced	ncont.	ufl.	coron.	nant. unst.
el	7	semiv.	liquid	central	alveolar	voiced	ncont.	ufl.	coron.	nant. unst.
w	6	semiv.	liquid	front	bilabial	voiced	ncont.	ufl.	coron.	ant. unst.
y	6	semiv.	glide	central	alveopalatal	voiced	ncont.	ufl.	coron.	nant. unst.
r	6	semiv.	retro	back	alveolar	voiced	ncont.	ufl.	ncoron.	nant. unst.
CLOSURES, SILENCE AND SHORT PAUSE										
vel	5	closure	voiced							
cl	5	closure	unv.							
sil	5	silence								
sp	3	pause								

Fig. 3

Phonetic table for the English language.

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VOWELS AND DIPHTHONGS										
iy	7	vowel	high	front	I	voiced	cont.	unround	long	tense
ih	6	vowel	high	front	I	voiced	cont.	unround	short	lax
ey	8	vowel	mid	front	E	voiced	cont.	unround	long	tense
eh	7	vowel	mid	front	E	voiced	cont.	unround	short	lax
ao	8	vowel	mid	back	O	voiced	cont.	round	—	lax
ae	9	vowel	low	front	A	voiced	cont.	unround	short	lax
aa	8	vowel	low	central	A	voiced	cont.	unround	—	lax
ax	5	vowel	mid	central	R	voiced	cont.	unround	short	lax
er	7	vowel	mid	central	E	voiced	cont.	unround	long	tense
an	8	vowel	mid	back	A	voiced	cont.	round	short	tense
ee	8	vowel	mid	front	E	voiced	cont.	unround	long	tense
eu	6	vowel	mid	front	E	voiced	ncont.	round	long	tense
in	6	vowel	high	central	I	voiced	cont.	unround	short	lax
iu	7	vowel	high	front	U	voiced	cont.	round	short	lax
yu	7	vowel	high	front	I	voiced	cont.	round	long	tense
oe	7	vowel	mid	front	O	voiced	cont.	round	short	lax
on	8	vowel	high	back	O	voiced	cont.	round	short	tense
oo	8	vowel	mid	back	O	voiced	cont.	round	long	tense
un	6	vowel	high	front	U	voiced	cont.	round	short	tense
uu	7	vowel	high	back	U	voiced	cont.	round	long	tense
ux	6	vowel	mid	back	R	voiced	cont.	round	short	lax
ai	8	dipht.			A	voiced	ncont.			
oi	10	dipht.			O	voiced	ncont.			
au	8	dipht.			A	voiced	ncont.			
CONSONANTS AND SEMIVOWELS										
p	5	cons.	stop	front	bilabial	unv.	ncont.	fortis	ncoron.	ant. unst.
b	5	cons.	stop	front	bilabial	voiced	ncont.	lenis	ncoron.	ant. unst.
t	5	cons.	stop	central	alveolar	unv.	ncont.	fortis	coron.	nant. unst.
d	5	cons.	stop	central	alveolar	voiced	ncont.	lenis	coron.	nant. unst.
k	5	cons.	stop	back	velar	unv.	ncont.	fortis	ncoron.	nant. unst.
g	5	cons.	stop	back	velar	voiced	ncont.	lenis	ncoron.	nant. unst.
ch	7	cons.	affricate	central	alveopalatal	unv.	ncont.	fortis	coron.	nant. strid.
jh	5	cons.	affricate	central	alveopalatal	voiced	ncont.	lenis	coron.	nant. strid.
f	7	cons.	fricative	front	labiodental	unv.	cont.	fortis	ncoron.	ant. nstrid.
v	7	cons.	fricative	front	labiodental	voiced	cont.	lenis	ncoron.	ant. nstrid.
s	8	cons.	fricative	central	alveolar	unv.	cont.	fortis	coron.	nant. strid.
z	6	cons.	fricative	central	alveolar	voiced	cont.	lenis	coron.	nant. strid.
sh	8	cons.	fricative	central	alveopalatal	unv.	cont.	fortis	coron.	nant. strid.
zh	7	cons.	fricative	central	alveopalatal	voiced	cont.	lenis	coron.	nant. strid.
h	5	cons.	glide	back	velar	unv.	ncont.	fortis	ncoron.	nant. unst.
m	5	cons.	nasal	front	bilabial	voiced	cont.	uff.	ncoron.	ant. unst.
n	5	cons.	nasal	central	alveopalatal	voiced	cont.	uff.	coron.	nant. unst.
ng	6	cons.	nasal	back	velar	voiced	cont.	uff.	ncoron.	nant. unst.
en	6	cons.	nasal	central	alveolar	voiced	ncont.	uff.	ncoron.	nant. unst.
l	6	semiv.	liquid	central	alveolar	voiced	ncont.	uff.	coron.	nant. unst.
w	6	semiv.	liquid	front	bilabial	voiced	ncont.	uff.	coron.	ant. unst.
y	6	semiv.	glide	central	alveopalatal	voiced	ncont.	uff.	coron.	nant. unst.
r	6	cons.	fricative	back	alveolar	voiced	ncont.	uff.	ncoron.	nant. unst.
pf	5	cons.	fricative	front	bilabial	unv.	ncont.	fortis	ncoron.	ant. nstrid.
ts	8	cons.	fricative	central	alveolar	unv.	ncont.	fortis	coron.	nant. strid.
x	5	cons.	fricative	back	velar	unv.	cont.	lenis	ncoron.	nant. nstrid.
CLOSURES, SILENCE AND short PAUSE										
vcl	5	closure	voiced							
cl	5	closure	unv.							
sil	5	silence								
sp	3	pause								

Phonetic table for the German language.

Fig. 4

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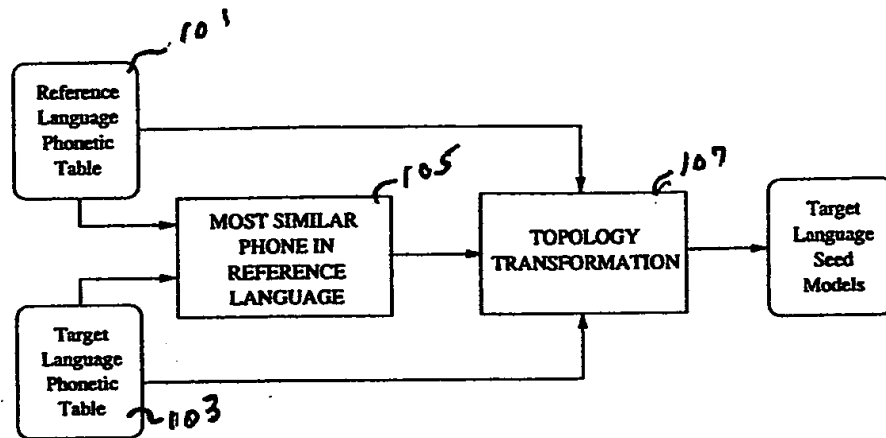
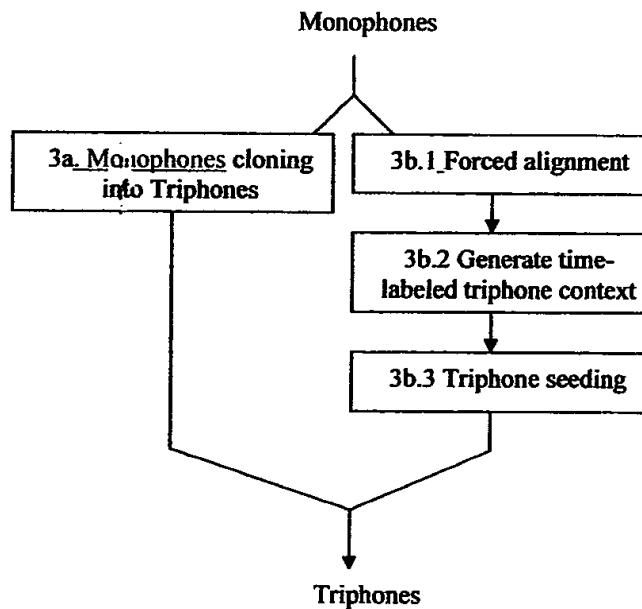


Figure 5 Block diagram of the proposed method for monophone seeding using the phonetic table of the target and reference languages.

Figure 6 Monophones to triphones transformation



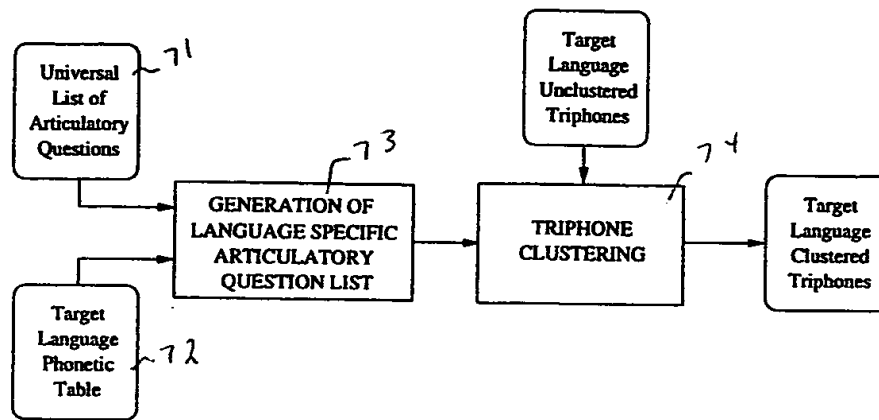


Figure 7 Block diagram of the proposed method for triphone clustering using the phonetic table of the target language and the universal list of articulatory questions.

QUESTION NAME	QUESTION DEFINITION	QUESTION NAME	QUESTION DEFINITION
Boundary	SILENCE	Unvcd.Closure	CLOSURE & UNVOICED
Vcd.Closure	CLOSURE & VOICED	Closure	CLOSURE
Front_stop	FRONT & STOP	Central_stop	CENTRAL & STOP
Back_stop	BACK & STOP	Affricate	AFFRICATE
Stop	STOP	Vcd_stop	VOICED & STOP
Unvcd_stop	UNVOICED & STOP	Nasal	NASAL
Front_nasal	FRONT & NASAL	Back_nasal	BACK & NASAL
Fric	FRICATIVE, AFFRICATE	Fricative	FRICATIVE
Voiced_Fric	(FRICATIVE, AFFRICATE) & VOICED	Vowel	VOWEL
Unvoiced_Fric	(FRICATIVE, AFFRICATE) & UNVOICED	Front_vowel	FRONT & VOWEL
Front_Fric	(FRICATIVE, AFFRICATE) & FRONT	Central_vowel	CENTRAL & VOWEL
Central_Fric	(FRICATIVE, AFFRICATE) & CENTRAL	Back_vowel	BACK & VOWEL
Back_Fric	(FRICATIVE, AFFRICATE) & BACK	Liquid	LIQUID
Central_cons	CENTRAL & CONSONANT	Back_cons	BACK & CONSONANT
Front_cons	FRONT & CONSONANT	High_vowel	HIGH & VOWEL
Mid_vowel	MID & VOWEL	Low_vowel	LOW & VOWEL
Front	FRONT	Central	CENTRAL
Back	BACK	Fortis	FORTIS
Lenis	LENIS		
Unfortlenis	UNFORTLENIS	Coronal	CORONAL
Noncoronal	NON_CORONAL	Anterior	ANTERIOR
Nonanterior	NON_ANTERIOR	Continuent	CONTINUENT
Noncontinuent	NON_CONTINUENT	Strident	STRIDENT
Unstrident	UNSTRIDENT	Nonstrident	NON_STRIDENT
Glide	GLIDE	Syllabic	SYLLABIC
Unvoiced_cons	UNVOICED & CONSONANT	Voiced_cons	VOICED & CONSONANT
Unvoiced	UNVOICED	Voiced	VOICED
Long	LONG	Short	SHORT
Diphtong	DIPHTONGUE	Semivowel	SEMIVOWEL
High	HIGH	Mid	MID
Low	LOW	Rounded	ROUND
Unrounded	UNROUND	Vocalic	VOWEL, GLIDE, LIQUID
Bilabial	BILABIAL	Labdental	LABDENTAL
Intidental	INTIDENTAL	Alveolar	ALVEOLAR
Alvpalatal	ALVPALATAL	Velar	VELAR
Nasalized_vowel	NASALIZED	Nasalized	NASALIZED, NASAL
Tense	TENSE	Lax	LAX
Front_long	FRONT & LONG	Mid_long	MID & LONG
Back_long	BACK & LONG	High_long	HIGH & LONG
Central_long	CENTRAL & LONG	Low_long	LOW & LONG
Front_short	FRONT & SHORT	Mid_short	MID & SHORT
Back_short	BACK & SHORT	High_short	HIGH & SHORT
Central_short	CENTRAL & SHORT	Low_short	LOW & SHORT
L_vowel	I	E_vowel	E
A_vowel	A	U_vowel	U
O_vowel	O	R_vowel	R
iy	iy	ih	ih
:	:	:	:
:	:	:	:

Fig. 8

Universal list of articulatory questions